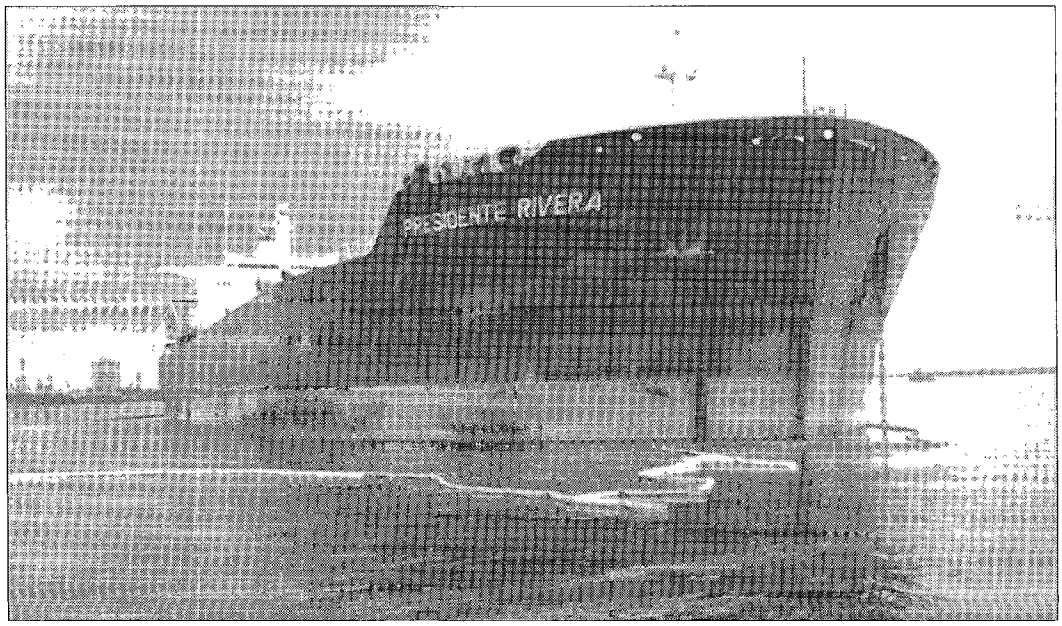
Improving Oil Spill Information for Delaware Bay

The Alternatives



On June 24, 1989, the T/V Presidente Rivera produced an oil spill in Delaware Bay of 7,300 barrels of Number 6 oil.

A cooperative project between:

U.S. Department of Commerce
National Oceanic and Atmospheric Administration

and

State of Delaware
Department of Natural Resources and Environmental Control

Origin and Purpose

This project was initiated at the request of the Delaware Department of Natural Resources and Environmental Control and Delaware Bay and River Cooperative to find a better way of determining resources at risk during an oil spill. NOAA was approached because of its experience in oil spill response, resource assessment, and information management. NOAA agreed to work with the State to provide a "blueprint" or "plan" specifying the necessary components for an oil spill information system and how it might be developed over several years. The result is three alternatives that will help the State to decide the level of resources it wants to apply to improve its oil spill information and information management capabilities.

Acknowledgments

The Project Team wishes to acknowledge the support and assistance of several individuals who contributed significantly to this report. Thomas LaPointe, Chief of NOAA's Decision Support Systems Branch, provided significant insight into the alternatives presented in this report for developing an oil spill response information system. Daniel Basta, Chief of NOAA's Strategic Environmental Assessments Division, conceived the original approach to developing this report and provided ongoing guidance and support. Robert Pavia, Chief of NOAA's Scientific Support Coordination Branch, offered sound advise on the use and management of information during a spill based on his years of oil spill experience. Eugene Johnson, President of the Delaware Bay and River Cooperative (a nonprofit oil spill response group financed through private oil companies with facilities on Delaware Bay), provided partial funding to NOAA for this project. Edwin Levine of NOAA's Hazardous Materials Response and Assessment Division provided the cover photo.

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Summary of the Alternatives

Three alternatives characterized by different levels of personnel and financial resources have been developed to provide the State of Delaware with choices for building an automated oil spill response information system for the Delaware River and Bay. These alternatives, summarized below, are discussed in more detail in this report.

1 - *Improved Data Management and Electronic Support*

This alternative would be implemented using existing State personnel who currently are dedicated to oil spill response. It features:

- Development of high priority map information
- Simple computer mapping
- Rolodex-type software and information

2 - *Enhanced Predictability of Resources at Risk*

Alternative 2 would require: 1) a full-time information management specialist; 2) the reallocation of existing State personnel to the equivalent of a full-time employee to develop spill response information; and 3) the contractual services of a spill trajectory modeling specialist. It includes:

- All features of Alternative 1
- Multi-layer electronic mapping
- Lap-top electronic map access in the field
- Simplified trajectory modeling for pre-spill planning
- Additional map information development

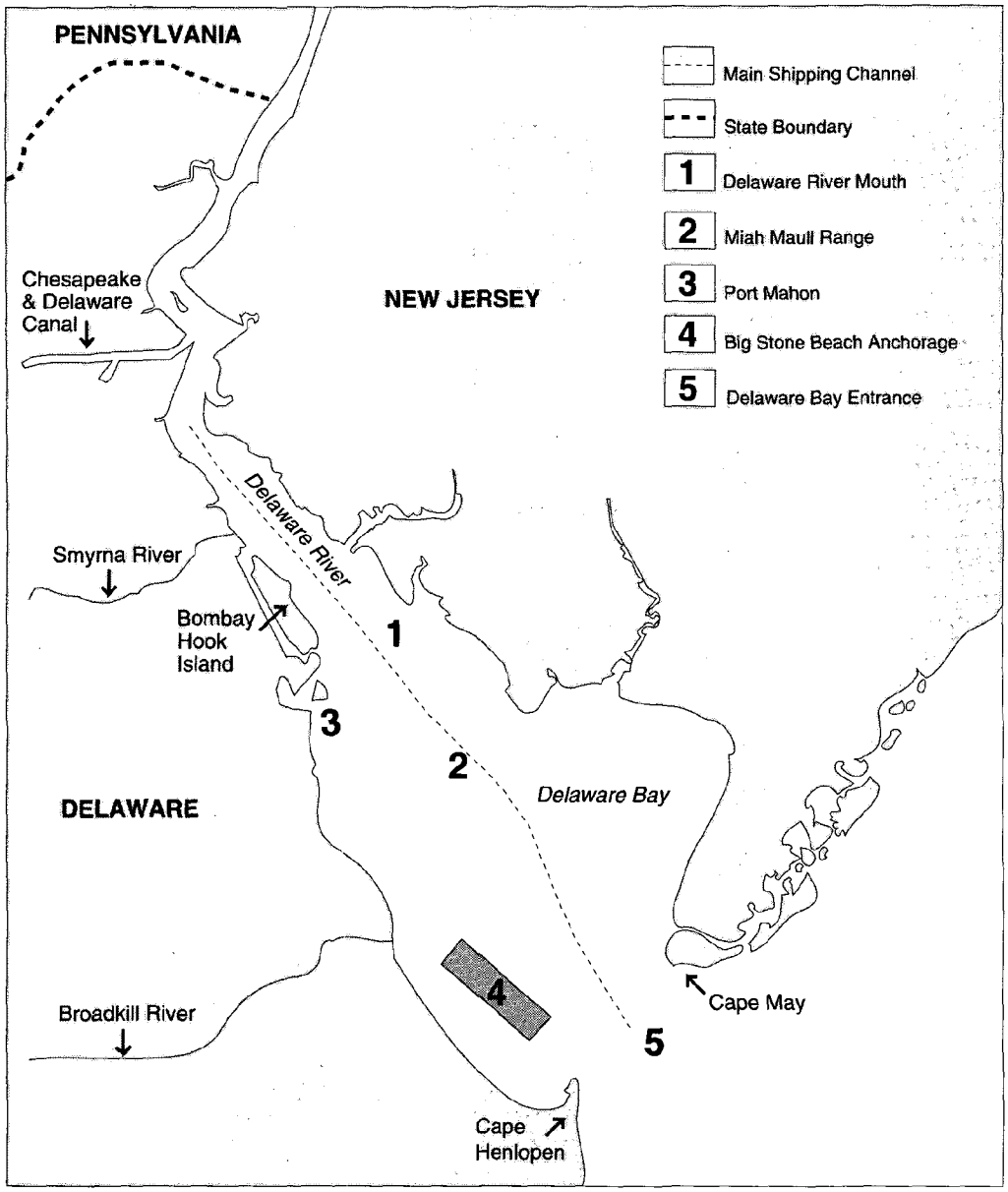
3 - *Real-time Logistics Management*

Alternative 3 would require between $100 and $200K per year for three years, as well as the staff resources in Alternative 2 and small annual network maintenance contracts. It provides for:

- All features of Alternative 2
- Remote access network capabilities during a spill
- Real-time information tracking

Contents

Introduction



This map identifies the sites in Delaware Bay where tanker accidents are most likely to occur. In 1990, nearly 1,000 tankers, 23,000 tugs, and 13,000 barges carrying crude oil and refined petroleum products travelled the Delaware River and Bay. (Source: Ecological Consulting, Inc.; Computer Based Planning for Protection of Sensitive Delaware Bayshore Habitats from Oil Spill Impact; Portland, Oregon; November 1992)

The Plan

- *IDENTIFIED all oil spill response information and information management requirements.*
- *ESTABLISHED priorities among them.*
- *ESTIMATED the level of effort required to develop the information and information management needs.*
- *DEVELOPED realistic alternatives of resource requirements to meet information and information management needs.*
- *BALANCED information needs with resources available.*
- *IDENTIFIED specific projects and tasks to meet immediate, mid-term, and long-term information and information management needs.*

This report provides the State of Delaware with alternatives for developing an oil spill response information system for Delaware River and Bay. Spill responders require prompt information concerning a spill to effectively conduct cleanup operations and to prevent extreme economic and biological damage. The spill response information system discussed in this report is targeted for large spills, such as the 462,000 gallons of crude oil from the T/V Grand Eagle grounding in 1986 or the 307,000 gallons of No. 6 fuel oil from the T/V Presidente Rivera grounding in 1989. During a typical year since the T/V Presidente Rivera spill, the State responds to about 12 vessel-related spills in Delaware Bay, each averaging about 6,000 gallons. U.S. Coast Guard statistics for the period between the Grand Eagle and Presidente Rivera spills indicate that about 1,000 spills occurred in Delaware River and Bay, each averaging 150 gallons.

The State's objectives in developing an oil spill response information system are to: 1) compile information supporting spill response into an automated system; and 2) generate paper copies of this information for use during an oil spill. As part of the Project Team, NOAA and Delaware's Department of Natural Resources and Environmental Control (DNREC) have developed a plan consisting of three alternatives (pages 14-25) to help meet these objectives. Each alternative consists of a different mix of information and information management capabilities based on different levels of resource requirements.

Why is a Plan Necessary?

Today, developing information and the capacity to manage it efficiently consists of a complex set of tasks. Information and the technology to manage it are changing rapidly and are challenging to evaluate. Acquiring the wrong tools for information management or the wrong information can be costly. As a result, detailed planning and specification of system capabilities take on increasingly greater importance. Previously arcane, back-room discussions on such topics as data structure, data organization, and ease of system operation must now be considered by resource managers for the effective design and operation of information systems. This plan is a first step in the planning process for an oil spill information system. However, more detailed planning will be required.

Delaware must make choices concerning the design and development of an oil spill information system from among: 1) many different types of information needed for effective spill response; 2) different ways to access and manage that information; and 3) the resources needed to develop some combination of both. With this plan, DNREC can balance its needs with its available resources and specify the appropriate mix of information and information management capabilities for development.

Effective oil spill response requires significant amounts of information. Knowing the properties of spilled oil, removal options, the spill's trajectory, biological and human resources likely to be affected, availability of cleanup supplies, and how to contact industry and government officials are just some of the information required to effectively manage an oil spill. The ability to access and manage this information during a spill is a prime consideration for spill responders. In this plan, DNREC and NOAA have: 1) identified spill response information and information management requirements; 2) established priorities among them; 3) identified work tasks required to develop the information; and 4) estimated the effort required to accomplish the work tasks.

How was this Plan Developed?

The process for developing this plan consisted of: 1) identifying information requirements and establishing the priority of each; 2) defining the characteristics of existing or desired data that satisfied the information requirements; 3) defining the improvements required to the information content and form of existing data; 4) identifying work tasks to create the desired data or to improve existing data; and 5) recommending the mix of information content and management capabilities for different resource levels. Participants and their respective roles are noted on page 5.

Understanding Information Needs. A three-day meeting with representatives from five divisions of DNREC was conducted in February 1993 to identify the data sets used in oil spill response. The result was a list of over 100 data sets. To make the task of evaluating them manageable, subsequent discussions focused on those data sets of highest priority to DNREC's Division of Air and Waste Management (DAWM), the unit responsible for spill response.

Defining "Data Set." Throughout this project, the term "data set" was used to refer to a topic or theme of information. However, to simplify project deliberations, the definition was narrowed to refer to a set of information that can be portrayed on a map or organized into a spreadsheet. This means that narrative reports, diagrams, written procedures, guidelines, policy statements, and similar text-based information were not considered as data sets to be updated or developed. This reduced the number of data sets to be characterized and evaluated to 63.

Characterizing Information. DAWM personnel completed three questionnaires (Appendix A) to characterize data sets necessary for spill response and specified the desired improvements to their information content, form, and management capabilities. More detailed discussions of desired improvements were conducted at later meetings to supplement and clarify the information provided on the questionnaires.

Assessing Resource Requirements. Eighteen work tasks (Appendix B) were identified to develop or improve the content of an existing data set or create a new data set. Each data set was evaluated to estimate the work tasks and level of effort required to develop a consistent electronic version of each data set. These estimates, along with estimates on the level of effort for developing the capabilities, are the basis for the information content and management capabilities recommended under the three alternatives presented in this report.

Participants and their Roles

The Strategic Environmental Assessments Division and the Hazardous Material Response and Assessment Division, Office of Ocean Resources Conservation and Assessment, NOAA

- Designed the project
- Organized and conducted meetings to identify desired information and information management capabilities
- Analyzed work tasks required to develop the desired information content
- Identified and recommended the data sets and information management capabilities that could be developed under different alternatives of resource availability
- Co-authored final report

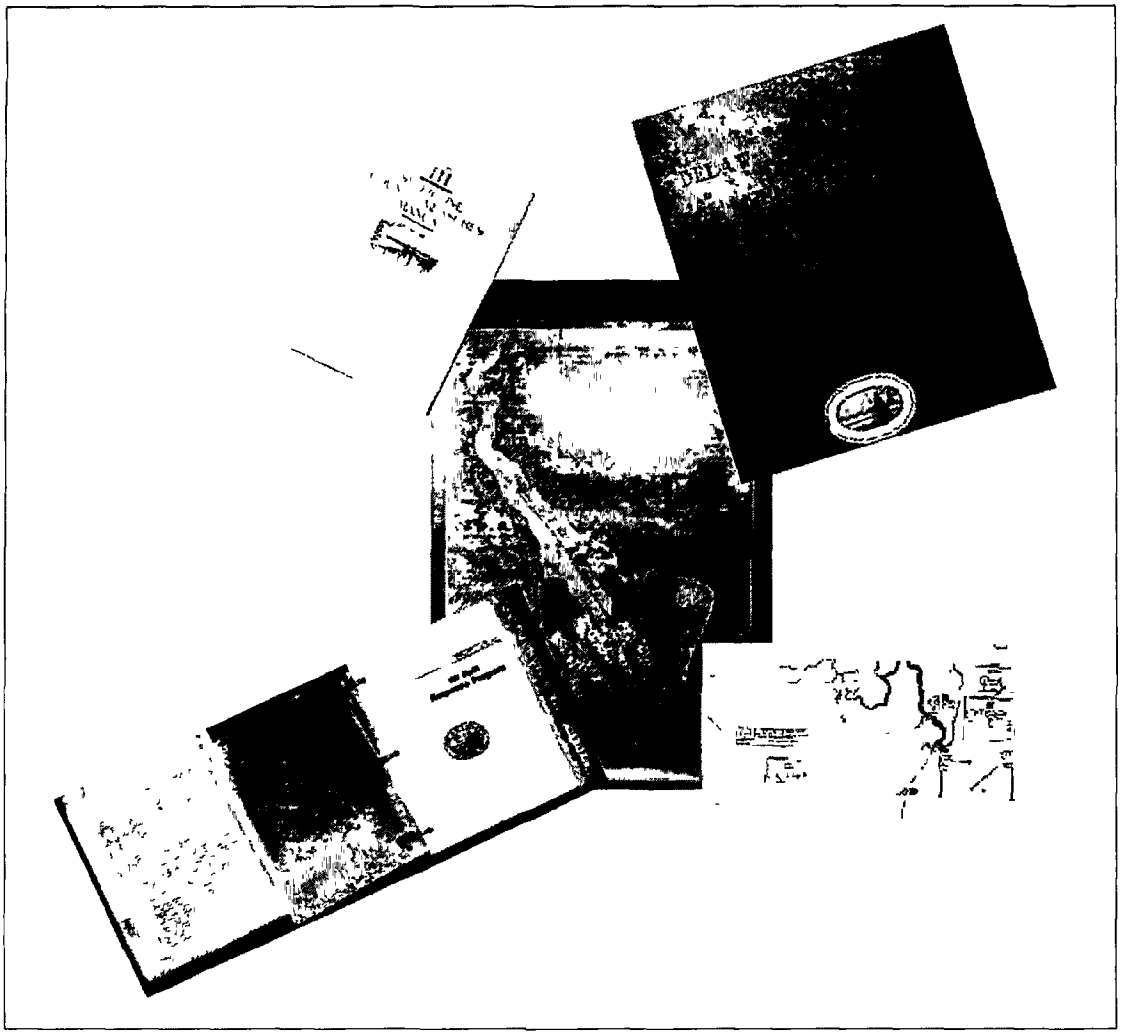
Delaware Department of Natural Resources and Environmental Control, Division of Air and Waste Management

- Identified information and information management capabilities
- Set priorities for information
- Characterized information sources and specified desired improvements to content, form, and information management capabilities of existing data used for spill response
- Co-authored final report

Delaware Bay and River Cooperative

- Provided partial funding to NOAA to conduct the work

Delaware's Existing System



The Delaware Oil Spill Response Contingency Plan, Environmental Sensitivity Index (ESI) maps, the Delaware Bay and River Cooperative Oil Spill Response Plan, and the Shoreline Countermeasures Manual are some of the sources currently used by Delaware oil spill responders during oil spill cleanup operations

State responsibility for oil spill cleanup resides with DAWM's Environmental Response Branch (ERB). Six individuals staff the ERB, but personnel from all five divisions of DNREC are available for significant spills. During a spill event, ERB relies on basic spill management information provided in the Delaware Oil Spill Response Contingency Plan. However, the plan does not provide information on resources at risk or shoreline spill management control. For this type of information, ERB must consult and coordinate with the divisions of DNREC or consult other information sources.

Oil Spill Response Contingency Plan

The Delaware Oil Spill Response Contingency Plan (hereafter, referred to as "the Contingency Plan") is the primary information source for State oil spill responders. It provides 50 appendices including: lists of contacts to notify during a spill; oil removal contractors; tide gates; archeological sites; water intakes; and other information required for logistical support during a spill. Most of this information is in a large spiral-bound notebook and in spreadsheet data files. Also in the Contingency Plan are paper copies of topographic maps marked by hand with important features. Although a very important information source for spill responders, these appendices and maps need to be updated regularly. Adding other information such as species and habitat distributions, shoreline types, and boom locations to maps would greatly enhance the ability of Delaware's oil spill responders to judge the resources at risk during a spill.

Intra-agency Coordination

Most natural resource information needed by spill responders is obtained simply by calling personnel in the other four divisions of DNREC: Water Resources; Soil and Water; Fish and Wildlife; and Parks and Recreation. This approach has worked well because these organizations have the most current information and firsthand knowledge of resources at risk. Even with a more automated system of retrieving this information, State spill responders will likely continue to rely on personal contacts within DNREC for the most up-to-date information. However, establishing its own organized file structure for some of this information would help DAWM to access and update information held by other divisions in DNREC.

DNREC's geographic information system (GIS) is a potential resource for generating, updating, and maintaining electronic map coverages for an improved spill response mapping capability. Although not currently used by Delaware's spill responders, GIS files can be made compatible with simpler mapping software for desktop or lap-top field computers. To illustrate this, some of Delaware's GIS files were used to create an electronic map for this project using desktop mapping software (Figure 5, page 26).

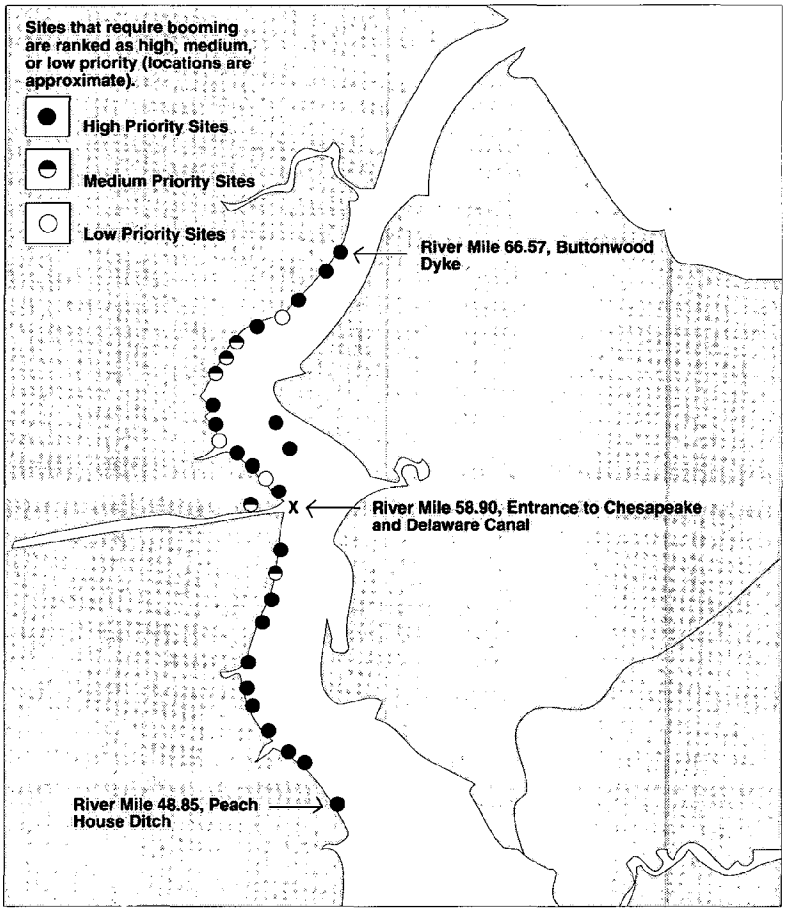
Mix of Information Sources

Other information sources developed by organizations participating in oil spill cleanup operations are valuable to Delaware's spill responders. Some of these include NOAA Environmental Sensitivity Index (ESI) maps, the Delaware Bay and River Cooperative Oil Spill Response Plan, the Shoreline Countermeasures Manual, and NOAA nautical charts. These sources are found in various paper and electronic products. Additional information is also generated after a spill occurs (e.g., spill and weather status, disposal tracking, and cleanup costs).

Delaware's Requirements

Appendix 16. River Mile List

Boom Position Number	Point	River Mile Location	Estimated Boom Required at this Site	24-Hour Spill Range	24-Hour Boom Required
55	Chesapeake and Delaware Canal Channel Entrance	58.90	1500 feet	66.57 / 48.85	22699
	H - 31, 32, 36, 40-43, 46-48, 51, 53, 55, 56, 60, 64, 65, 66, 68, 70-75 M - 30, 37, 38, 39, 52, 61, 63 L - 33, 45, 49				
56	Scotts Run				
57	Lums Po				



Automating information from the Oil Spill Response Contingency Plan should make information more portable and accessible to spill responders as shown here by an electronically generated map of River Mile features.

Data Set Definitions

- *Rolodex-type. With one exception, these data sets are developed before spill response and are typically lists of names, addresses, phone numbers, and response capabilities. They are easy to develop and update.*
- *Map-based. These data sets consist of information that can be illustrated on a base map (i.e., the location of tide gates, water intakes, and historical sites). Additional data to characterize these map features are also part of these data sets. They are developed before responding to a spill.*
- *Real-time. These data sets (e.g., spill status, disposal tracking, cumulative cost of cleanup, etc.), developed during a spill, present a complex problem of data input protocols and information management with the need to summarize data in real time.*

The primary needs to improve Delaware's current spill response system are: 1) centralizing information sources that must be located and consulted; 2) updating information already in the Contingency Plan; 3) making information in the Contingency Plan notebook more portable and accessible to spill responders; 4) providing spill responders with updated paper maps showing specific resources at risk during a spill; and 5) better managing the information generated during a spill response.

Information

Sixty-three data sets were identified as required to respond effectively to a large oil spill in Delaware Bay. They were classified into ten categories and a priority assigned to each based on their importance to spill response personnel (Table 1). Many data sets in the categories of Contacts, Response Hardware, Response Services, and Map Information are in the Contingency Plan but require routine updates. Others (i.e., shoreline types, boom deployment locations, and priority options) are found in other sources such as ESI maps, the Delaware Bay and River Cooperative Oil Spill Response Plan, and the Region III Regional Response Team's Shoreline Countermeasures Manual. Still others (e.g., fuel pipelines) need to be developed from several scattered sources.

Estimates were made of the effort required to develop/update all 63 data sets or to consolidate them from sources outside the Contingency Plan into a single system (Table 1). The estimates were made for comparison and provide a relative sense of the effort required. These estimates should be considered approximate only (Appendix B).

Data sets were grouped into three types to assign data development to the appropriate alternative of resource requirements. In general, Rolodex-type data are developed under Alternative 1; map-based data under Alternative 2; and real-time data under Alternative 3. A few data sets such as those in the categories of Spill References and Response Documentation do not fall into any of the three types.

Information Management

Delaware's ultimate objective is automated access to all data supporting spill response, with the ability to generate hard copies at the scene of the spill—thus, centralizing all data currently used in spill response now scattered in different reports, agencies, and data files.

Of special importance is the need for desktop computer mapping to display features on a map (e.g., points, polygons, or lines), as well as data associated with these features. The map may be a simple one showing a single category of data with a single theme or it may be more complex with multiple data categories and multiple themes. For Delaware's oil spill information system, the geographic areas covered by base maps and the various themes and data categories incorporated on these maps will be the subject of research and experimentation.

Examples of other capabilities to be part of its oil spill information system are as follows:

- Rolodex-type software with find and update capabilities to locate information easily on spill responders, services, and suppliers

Table 1. *Data Sets, Categories, Priorities, and Level of Effort*

Categories (Priority)	Type of Data Sets				Level of Effort			
	Rolodex	Map Based	Real-time	Other	0-4 (Person Weeks)	5-12 (Person Weeks)	13-26 (Person Weeks)	>26 (Person Weeks)
Contacts (1)								
Delaware Environmental Alert Call System	●				●			
DAWM SERT Volunteers and Phone Numbers	●				●			
DNREC Cellular Phone and Fax Numbers	●				●			
Emergency Response Agencies, Names & Phone Numbers	●				●			
DBRC Member Company, Refineries, and Terminals	●				●			
Incident-specific Contacts	●		●		●			
Map Information (2)								
Base Map								
State/Political Boundaries		●			●			
Waterbodies		●			●			
Shoreline		●			●			
Roads		●			●			
Cities		●			●			
Railroads		●			●			
Bridges		●			●			
Topography		●			●			
River/Ocean Mile List		●			●			
Fixed Station Monitoring Network		●			●			
Map Content								
Shoreline Type		●				●		
Wetlands		●					●	
Living Marine Resource Inventory		●				●		
Boom Deployment Locations		●			●			
Natural Collection Areas		●				●		
Staging Areas		●				●		
Bathymetry		●				●		
Navigation Aids		●				●		
Recreation Sites		●				●		
Land Ownership		●			●			
Industrial Facilities		●			●			
Fire Departments/Field Command Posts		●			●			
Fuel Pipelines		●					●	
Water Intakes		●			●			
Tide Gates		●			●			
Archaeological, Historic, and Cultural Sites		●			●			
Shoreline and Water Access Points		●					●	
Spill References (3)								
Delaware Tide Tables & Tidal Currents			●		●			

Table 1. *Data Sets, Categories, Priorities, and Level of Effort (Continued)*

Categories (Priority)	Type of Data Sets				Level of Effort			
	Rolodex	Map Based	Real-time	Other	0-4 (Person Weeks)	5-12 (Person Weeks)	13-26 (Person Weeks)	>26 (Person Weeks)
Response Hardware (4)								
Early Assessment Equipment and Supplies	●				●			
Communication Equipment	●				●			
Communication Frequencies	●				●			
Helicopters Available	●				●			
Boats Available	●				●			
Spill Management (5)								
Status Board			●		●			
Health and Safety Plan			●		●			
Priority Cleanup Options by Site			●		●			
Logistics Tracking			●		●			
Work Plan			●		●			
Cost Tracking			●		●			
Disposal Tracking			●		●			
Response Services (6)								
Cleanup Contractors	●				●			
Wildlife Coordinators/Rehabilitators	●				●			
Qualified Laboratories	●				●			
Spill References (7)								
Spill Products vs. Chemical Products				●	●			
Chemicals Allowed for Use				●	●			
Dispersant Evaluation				●				●
Spill Impacts (8)								
Post Spill, Preimpact Baseline				●				●
Spill Impacts (9)								
Impacts, Actual (Shoreline)			●		●			
Impacts, Actual (Water)			●		●			
Spill Impacts (10)								
Natural Resource Impacts			●		●			
Natural Resource Monitoring, Short-Term			●		●			
Natural Resource Monitoring, Long-Term			●		●			
Response Documentation (11)								
Response Documentation				●	●			
Damage/Natural Resource Damage Documentation				●	●			
Cost Recovery				●	●			
Final Report				●	●			
Response Locations (Undefined)								
Public Use Airports	●				●			

Information Management

Information management refers to the techniques and types of software tools available to manage, access, and analyze information contained in the data sets used in oil spill response. Information management capabilities desired by Delaware include:

- *Electronic Rolodex*
- *Electronic forms*
- *Desktop electronic mapping*
- *Graphic display software*
- *Electronic spreadsheet*
- *Modelling*
- *Real-time information tracking*
- *Remote access network*
- *Relational data base management*

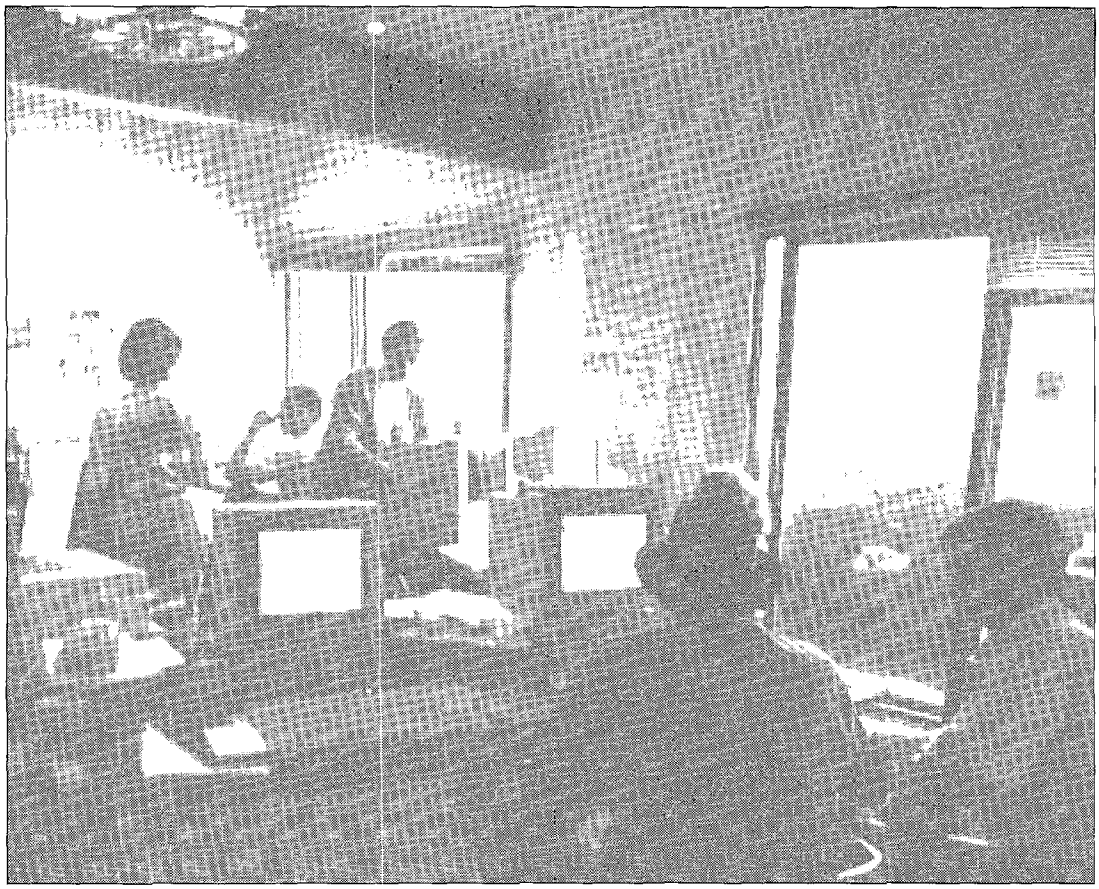
- Electronic spreadsheets to organize information to be added to electronic maps

- Real-time information tracking during a spill provided by network software and data entry to electronic forms

Other capabilities listed in the sidebar are discussed in each alternative (pages 16-25).

Most capabilities can be developed with commercially available software. Also, NOAA has adapted some of these capabilities in its Computer-Aided Management of Emergency Operations (CAMEO™) system and compatible "spill tools" that have been developed to specifically address oil spill response requirements. CAMEO is a group of modules that can be combined to meet specific information requirements. Each module provides: 1) a simple, easily understood design and 2) the ability to be adapted to local situations. It is a combination of information and decision tools that include chemical information and other data bases, adaptable templates for managing information, simulation models that help decision makers interpret information, maps showing spatial relationships among data and the results of simulation models, and searching and reporting capabilities.

The Delaware Fire Academy has already adopted CAMEO as its official emergency management software for hazardous material incidents. With little alteration, CAMEO can be used to accommodate some of Delaware's oil spill information management needs. Rolodex-type data sets and spill reference data (e.g., oil properties) can be incorporated into CAMEO. Also, a significant percentage of information currently in CAMEO is common to the needs of two emergency response groups in DNREC.



Computer access to maps, data, and automated information management is Delaware's ultimate objective for improving its ability to manage oil spill cleanup in Delaware River and Bay.

The Alternatives

Table 2. *Content of Each Alternative*

	Existing Delaware's Response System	1 Improved Data Management and Electronic Support	2 Enhanced Predictability of Resources at Risk	3 Real-time Logistics Management
Data Set Category (Priority)				
Contacts (1)	◎	●	●	●
Map Information (2)				
Base Maps	◎	●	●	●
Map Content	◎	◓	●	●
Spill References (3)*	●	●	●	●
Response Hardware (4)	◎	●	●	●
Spill Management (5)	◎	◎	◓	●
Response Services (6)	◎	●	●	●
Spill References (7)*	◎	◓	◓	◓
Spill Impacts (8)*				
Spill Impacts (9)*	◎	◎	◎	●
Spill Impacts (10)*				●
Response Documentation (11)	◎	◎	◎	◎
Information Management Capabilities				
Bound or Loose-leaf Volume	✓	✓	✓	✓
Electronic Spreadsheet	✓	✓	✓	✓
Electronic Rolodex		✓	✓	✓
Simple Desktop Computer Mapping		✓	✓	✓
Display Software (Graphics for Maps)		✓	✓	✓
Advanced Desktop Computer Mapping			✓	✓
Modelling			✓	✓
Data File Management			✓	✓
Electronic Forms				✓
Tracking				✓
Remote Access Network				✓
Relational Data Base Management				

*Categories appear more than once because priorities reflect the different data sets within categories. See Table 1 (pages 10 & 11) for the data sets included in each category/priority combination.

● Data sets complete

◎ Data sets exist but need to be updated

◓ Data sets partially complete

✓ Presence of capability under Delaware's existing spill response system or under the proposed alternatives.

Three alternatives of increasing levels of resource investment, each spanning three years, are proposed to develop different mixes of information and information management capabilities, with the features of each alternative building on the previous one. Table 2 summarizes the information content and capabilities of Delaware's existing spill response system and those that would exist under each of the three proposed alternatives. Each alternative is discussed in this section.

What is Included?

The first alternative makes maximum use of dedicated spill response personnel in the DAWM. Emphasis is on developing simple Rolodex-type data files, map information content, and simple electronic mapping capabilities.

The second provides for a full-time data base administrator dedicated to developing all information management capabilities and maintaining all data files. The equivalent of a second full-time individual from within DNREC would aid in assembling information needed for spill response. Emphasis would be on developing the additional map information content. The contractual services of a modeling expert may be required to run and interpret results of an oil spill trajectory model.

The third assumes that $100 to $200K per year (for three years) is available for contract work to develop software and procure hardware for managing information generated during a spill. This would include a remote access network to centralize and track information during response operations.

Three alternatives are proposed for several reasons. First, each provides for development of distinctly different sets of information and capabilities. Second, succeeding alternatives provide for significant levels of increased data and data management over Delaware's existing system and each other. Third, the resources required by each are modest and reasonable. Finally, three alternatives are a manageable number to consider and are points of departure for developing other mixes of information and capabilities. Presenting more than three could blur the distinction among them.

What is not Included?

Three questionnaires were used to develop the contents of data sets needed for spill response (Appendix A). A few data sets and one information management capability are not covered under any of the three resource alternatives. They are:

- ***Data Sets Requiring Field Work.*** Two data sets, dispersant evaluation and post spill/pre-impact baseline, would require significant field work to develop the information desired by Delaware's spill responders. Dropping the development of these data sets under these alternatives is recommended because of the estimated two-year effort level required.

- ***Response Documentation Data Sets.*** Developing these data sets depends on the remote access network, electronic forms, and the information tracking capabilities under Alternative 3. Response documentation would draw on the spill management information and spill impacts documentation that will be generated with the electronic forms and information tracking capabilities.

- ***Delaware Tide Tables and Tidal Currents.*** This data is generated by software already used by Delaware spill responders. No updates or additional information is required.

- ***Relational Data Base Capability.*** This refers to the ability to associate information from different data sets. To do this, special software, special design of data tables, and relational data base management expertise are required. Delaware should consider developing this capability only after implementing all others.

Alternative 1 - Improved Data Management & Electronic Support

This alternative calls for one to two individuals from the existing staff of the DAWM to be responsible for several information development and management activities. These would be conducted as time permitted between spills and other duties, and would include: 1) updating simple data sets used in spill response; 2) incorporating that data onto Rolodex or data base software for easy access; and 3) developing a simple desktop computer mapping capability (Figure 1). This mapping capability will improve, but not replace, reliance on hard-copy lists, maps, and notebooks during a spill.

Resource Requirements

- One to two individuals from existing spill response staff for about 36 person-weeks a year for three years
- $10-$15K for computer hardware and software

Data Sets to be Updated or Developed

CONTACTS

- Delaware environmental alert call system
- DAWM SERT volunteers and phone numbers
- DNREC cellular phone and FAX numbers
- Emergency response agencies/names and phone numbers
- Delaware Bay and River Cooperative member company, refineries, and terminals

MAP INFORMATION (BASE MAP)

- State/political boundaries
- Waterbodies
- Shoreline
- Roads
- Cities
- Railroads
- Bridges
- Topography
- River/ocean mile list
- Fixed station monitoring network

MAP INFORMATION (MAP CONTENT)

- Shoreline type
- Tide gates
- Water intakes
- Fire departments/field command posts
- Staging areas
- Archaeological, historic, and cultural sites
- Recreational sites
- Navigational aids (will require NOAA's assistance)
- Land ownership
- Industrial facilities

RESPONSE HARDWARE

- Early assessment equipment and supplies
- Communication equipment
- Communications frequencies
- Helicopters available
- Boats available

RESPONSE SERVICES

- Cleanup contractors
- Wildlife coordinators/rehabilitators
- Qualified laboratories

RESPONSE LOCATIONS

- Public use airports

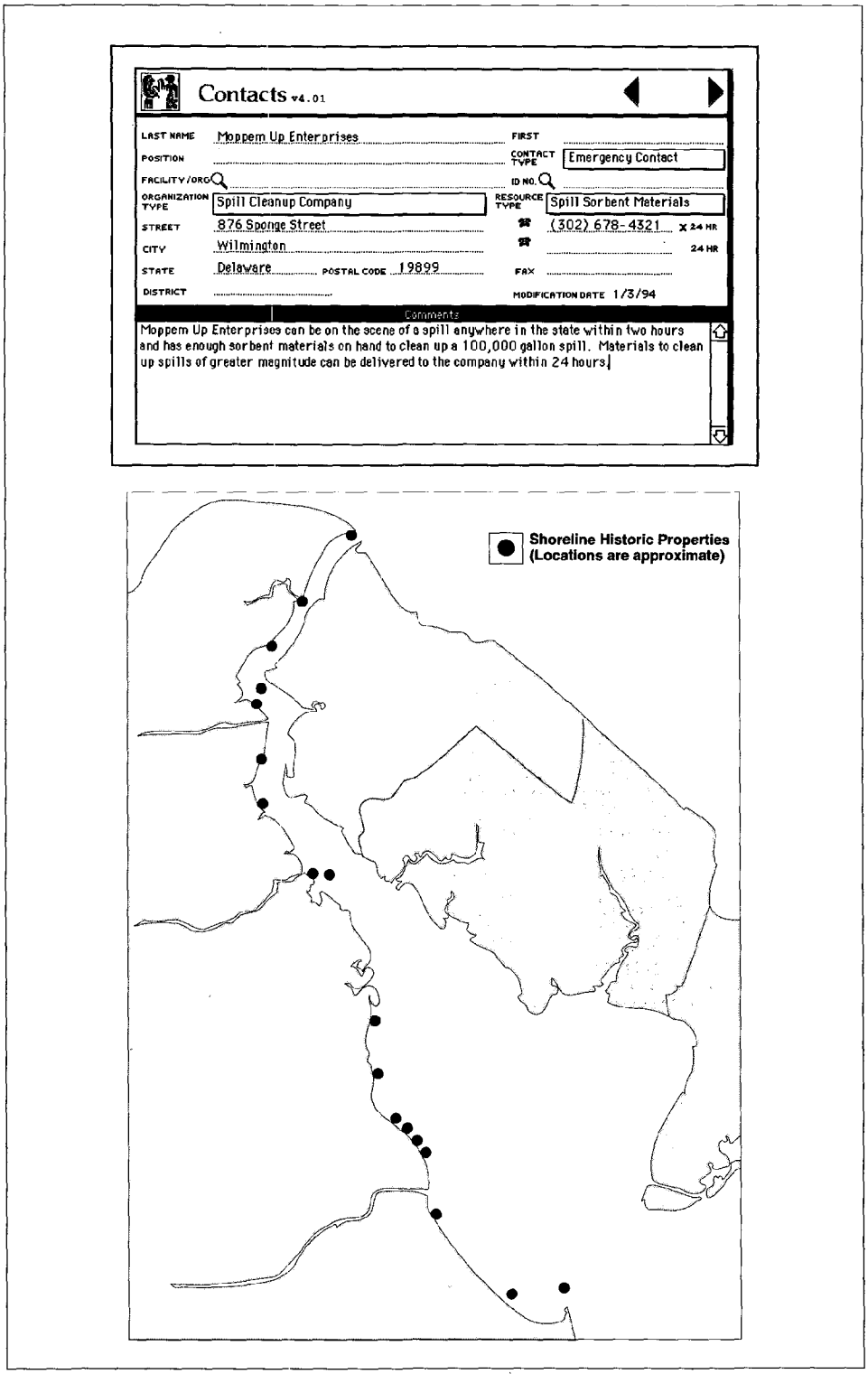
Comments and Considerations

While data sets in the Map Information category are a higher priority, those in the Response Hardware, Response Services, and Response Locations categories would require only about 17% of staff resource time under this alternative to update or develop the data sets. This would complete all the Rolodex-type data sets under Alternative 1.

Information Management Capabilities

- Data base or Rolodex-type software with search, find, and update capabilities for easy access to the information content of data sets in the Contacts, Response Hardware, Response Services, and Response Location categories
- Spreadsheet software for managing the data associated with points, polygons, and vectors of data sets in the Map Information category displayed on base maps of Delaware Bay
- Desktop mapping software for creating simple thematic maps

Figure 1. *Major Features of Alternative 1*



Two major features of Alternative 1 are spill response information on Rolodex-type software from CAMEO™ (above) and a desktop computer map with a single theme of information (below).

- Display software for enhancing and printing hard-copy maps created with mapping software
- Bound or loose-leaf volume of simple thematic maps and associated data generated in desktop mapping software for use in the field during spill response

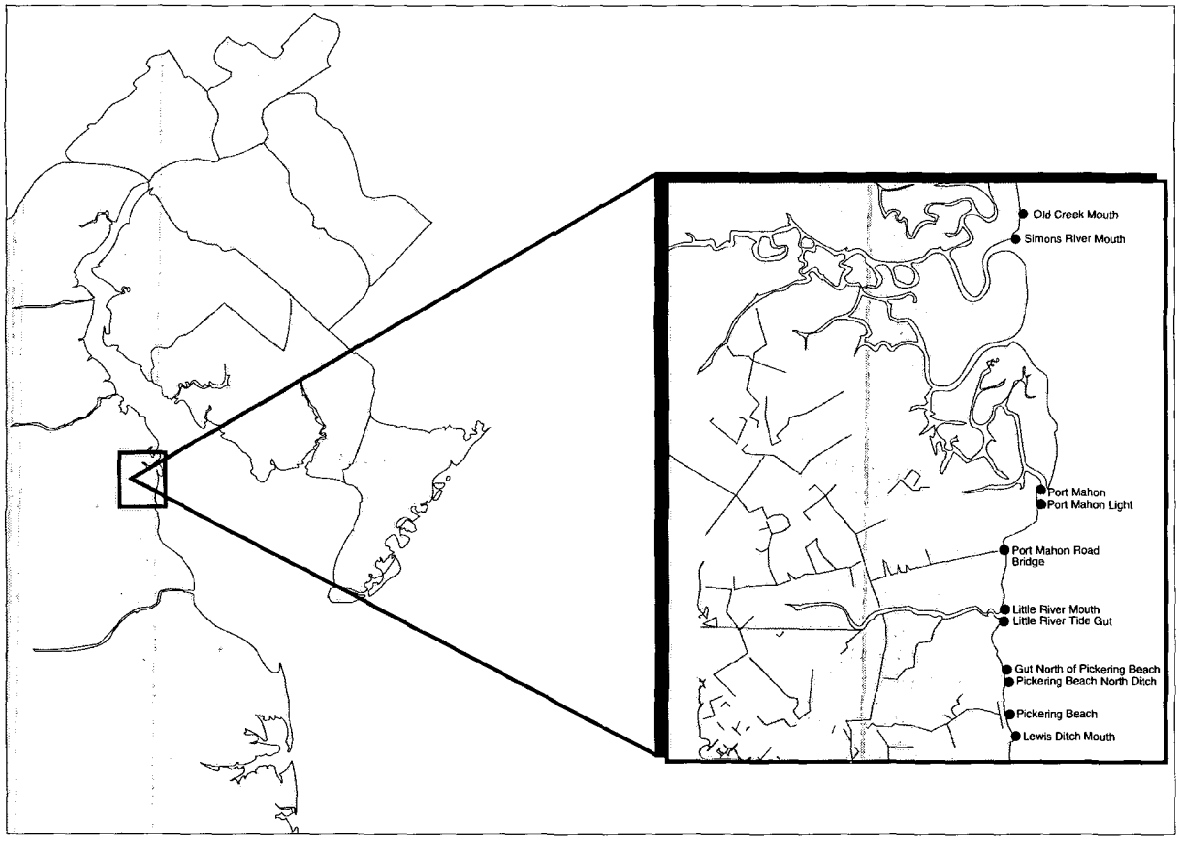
Comments and Considerations

For each information management capability associated with computer software, research will be conducted to determine: 1) the most appropriate application; 2) an acquisition process for the software; 3) training of spill response personnel in software use; and 4) data input. All software would be commercially available *off the shelf.*

Most of the work effort to implement this alternative will be spent developing the electronic mapping capability. This includes designing a system of maps and their information content, developing data for map information, implementing the design, and training in the use of desktop mapping software. The mapping capability will provide simple thematic maps (i.e., a single layer or theme of information added to a base map). The maps would be printed from graphics software that can be used to enhance the display of maps created in a mapping application. They would be bound or placed in a loose-leaf volume with spreadsheets of accompanying data that could be taken into the field during spill response. An example of a simple thematic map of Delaware Bay is shown in Figure 1.

Creating thematic maps will require some assistance from DNREC's geographic information system (GIS) to provide the necessary geographic files. NOAA experimented with the development of a desktop map of the Little Creek, Delaware 1:24,000-quad using existing geographic coverages available from DNREC's GIS. Electronic map files were converted to a file format compatible with desktop mapping software. Point features such as tide gates, marinas, and archaeological sites shown on the Little Creek quad map in the existing Delaware Oil Spill Response Contingency Plan were transferred to a NOAA nau-

Figure 2. *Map of Little Creek, Delaware area*



tical chart of the area. Latitude and longitude coordinates for these points were generated by electronically scanning the nautical chart. These points were then added to the map files obtained from the GIS. A map of the area is shown in Figure 2.

Summary

This alternative provides a cost-effective means of achieving the objectives of Delaware spill responders to develop a computer mapping capability and update many important data sets. It can be implemented at a small cost for several pieces of computer software and perhaps an additional computer work station. No major changes in personnel within DAWM would be required; only a change of responsibilities related to information management would be required for one or two individuals. This alternative is a solid step toward building information management skills in support of DAWM's mission of spill response.

Alternative 2 - Enhanced Predictability of Resources at Risk

This alternative provides for the hiring of a full-time information management specialist and the equivalent of a full-time employee from within existing DNREC personnel. The information management specialist would be responsible for: 1) conducting all software and hardware research, acquisition, and testing; 2) training others in the use of all hardware and software; 3) managing all electronic data files and hard-copy information sources used in spill response; 4) managing all electronic mapping; 5) overseeing simplified trajectory model runs for pre-spill planning (Figure 3); and 6) updating and developing data sets. The full-time individual allocated from existing personnel in DNREC would develop information necessary for spill response.

The major differences between this and the first alternative are the development of multi-layer electronic mapping, the use of a simplified spill trajectory model for pre-spill planning, and the development of additional map-based data.

Resource Requirements

- All personnel resources available in Alternative 1
- One full-time information manager for three years
- One full-time equivalent position from within existing DNREC personnel for three years
- $15-$20K for computer hardware and software
- $25K for modeling specialist contract

Data Sets to be Updated or Developed

DATA SETS FROM ALTERNATIVE 1

MAP INFORMATION

- Living marine resource inventory
- Wetlands
- Shoreline and water access points
- Fuel pipelines
- Bathymetry (will require NOAA's assistance)
- Boom deployment locations

SPILL MANAGEMENT

- Priority cleanup options by site

SPILL REFERENCES

- Spill products vs. chemical products

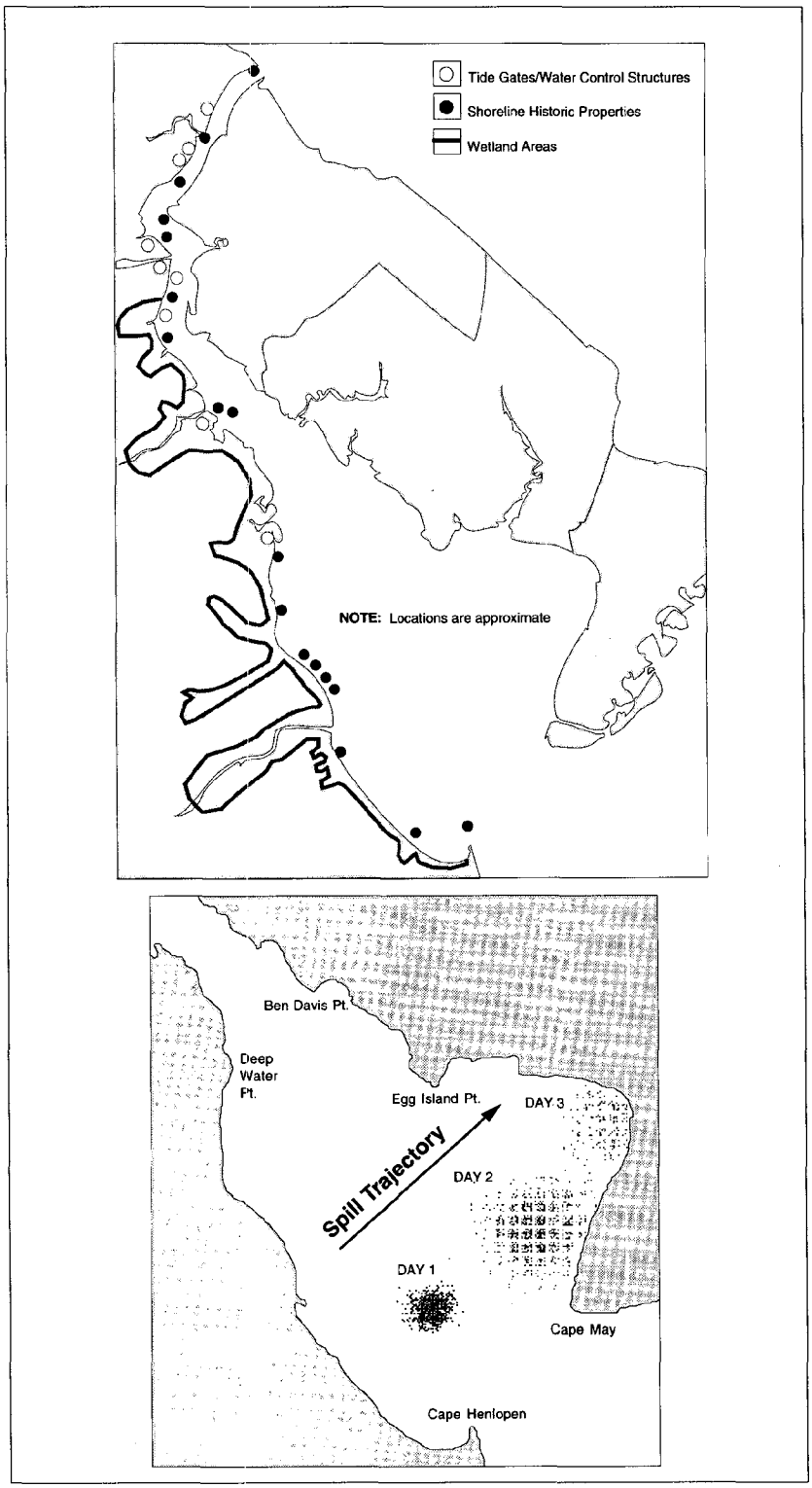
Comments and Considerations

As a group, the data sets proposed for development under this alternative pose the most challenges. The technical transfer of existing wetlands, bathymetry, and living marine resources data to a common set of electronic base maps designed specifically for Delaware oil spill response may pose problems due to file size, "edge matching" or congruency, and differences in scales. Assembling data sets from multiple sources will be especially challenging for fuel pipeline, shoreline, and water access points on Delaware River and Bay due to the potentially large number of sources to be contacted. During the course of this project, several of these data sets required special consideration as discussed below.

Living Marine Resource Inventory. Initial discussion of this data set revealed the desire to conduct a lengthy synthesis of existing information sources. Delaware hoped to gather enough existing information, with updated supplements from annual surveys, to show the seasonal distribution of fish, mammals, birds, and invertebrates by life stage and habitat on desktop maps of Delaware Bay. Estimates to complete this effort were two person-years. Reasons that could significantly increase the estimated two person-year effort for building this data set are:

- including too many species in the data set. Only the most important from a recreational, commercial, or ecological standpoint may suffice.
- attempting to include too much detail on spatial and temporal locations and distributions. While studies for some species may be very detailed, others may be less detailed. However, all sources will have to fit into a common information framework and this typically reduces the data to the broadest level.
- establishing the study design and methods. A significant amount of time needs to be spent "up front" to design the process for gathering and reviewing information. Numerous "dry runs" to test the methods will also be required.

Figure 3. *Major Features of Alternative 2*



Two major features of Alternative 2 are multi-theme desktop computer mapping (above) and simplified spill trajectory modeling for pre-spill planning (below).

- underestimating the amount of time required to locate all data sources and to conduct a peer review.

- organizing and inputting the information for computer maps. Deciding how to represent this information on a desktop computer map and defining every step to put it into a computer will require substantial thought and testing.

Due to the likelihood for delay, the use of existing Environmental Sensitivity Index maps and Research Planning Institute (RPI) seasonal species distribution maps for mapped information on living marine resources is recommended.

Wetlands. Incorporating digital wetland map files from the National Wetlands Inventory on desktop maps is estimated to require 26 person-weeks. Because these files already exist and are available from DNREC's GIS, this may appear to be an overestimate. However, significant amounts of work could be required to separate different wetland types from the existing GIS file to place them on desktop maps. Until the configuration of desktop maps is specified, and the content and structure of existing GIS wetland files are analyzed, a more accurate estimate of the level of effort can not be obtained.

Boom Deployment Locations. Developing a data set on precise boom deployment locations for over 50 sites in Delaware Bay originally was estimated to require two person-years to conduct the necessary field tests. However, by using the existing Delaware Bay and River Cooperative's Oil Spill Response Plan, getting this information onto desktop maps and constructing a data file on the boom placement locations is estimated to only require about four person-weeks.

Information Management Capabilities

- Rolodex and spreadsheet capabilities from Alternative 1

- Multi-layer electronic mapping including experimentation to design optimum map configuration and content, and implementation of map design

- Running a simplified spill trajectory model for planning purposes to predict the movement of spilled oil and resources at risk at different locations in Delaware River and Bay under different meteorological and hydrodynamic conditions

- Bound or loose-leaf notebook with various spill scenarios as projected by the NOAA trajectory models

- Full-time data file management of oil spill response information

- Full-time configuration of management design and implementation of all software and data for computers used by spill responders

- Spill responder hardware and software training

Comments and Considerations

Multi-layer Desktop Computer Mapping. Desktop computer mapping refers to the creation, use, and analysis of electronic maps by nontechnical professionals. Multi-layer mapping refers to different themes of information presented as different layers of a single electronic map. The mapping software should be able to "look through" the layers where a spill has occurred or is likely to travel to determine the resources that may be affected. The objective would be to gain experience with the types of contingencies posed by spills under various conditions.

Designing a map system for multi-layer thematic mapping will also require extensive experimentation to find the appropriate combination of geographic areas and thematic layers. Obvious options for geographic map areas include the entire Delaware River and Bay and adjacent lands, the area of each USGS 7.5-minute quad covering Delaware Bay, smaller grid areas within each USGS quad now depicted on maps in the Delaware Oil Spill Response Contingency Plan.

Regardless of the number of maps, including all themes of information on each map would be impractical. Also, the size of the electronic map file would be too large to open easily. Consequently, Delaware would have to follow a trial-and-error process to determine the optimum combination of spatial areas covered on a map and the various layers to be placed on the map.

To help determine the optimum combination of geographic areas, base map geography, and data for desktop maps, DNREC can use its GIS capabilities. Existing geographic coverages from the GIS can be transferred to desktop mapping packages with little difficulty, assuming all coverages have been subjected to quality control. The process will include building a library of boundary files to determine the best mix of base map information. The library would be used

to build a series of base maps. Data could then be incorporated with these base maps for use in the field either electronically on a lap-top computer or bound in a series of printed maps.

Changes to base map geography should be completed using the GIS because of the ease in maintenance. The boundary file library would then be updated after these changes were made using the GIS. This library would make updating a particular layer on desktop maps trivial. Incorporating data to these updated geographic map layers would be easy with a properly maintained and structured library of boundary files. One person should document how to update the boundary file library and how to incorporate other data into the library in the future.

Simplified Trajectory Modeling. Undertaking the use of a trajectory model should not be done lightly or without considerable forethought. The ability to interpret model results is an important consideration before using this tool as part of an oil spill information system. Trajectory modeling would provide a capability for pre-spill planning, but would not be used during a spill.

Using a trajectory model could serve two purposes. First, it could be used to predict the areas of highest probability of spill impact prior to spill events. This would require a large number of model runs to account for various meteorological conditions, spill volumes, and types of material spilled. It would also need to be run for many different locations in Delaware River and Bay, such as those with the greatest likelihood of tanker accidents (see page 2). A thorough understanding of statistics would be necessary to interpret model results. The results of various model runs could be added as separate layers to multi-layer desktop maps and/or printed for a loose-leaf notebook. Second, model runs could be used to evaluate spill response plans. These would help to determine if resources available to cleanup a spill measure up to the requirements for spills of different magnitudes.

Depending on the complexity of the trajectory model, a modeling specialist may need to be hired to run it and interpret the results. NOAA's Hazardous Materials Response and Assessment Division is currently developing a trajectory model for planning. It provides a simplified user interface and a more sophisticated display of model results than the Oil Spill Simulation Model (OSSM), its current modeling tool. This reduces the need for training in model use and the possibility of misinterpreting model results. Regardless of the complexity of the model selected, using a modeling tool should be one of the last items undertaken as part of this alternative.

Summary

Alternative 2 will require a modest annual increase in DAWM's budget. This will pay for a mid-level information management specialist, a one-time cost for computers and software for the management specialist and spill response personnel, and perhaps, a modeling specialist to conduct a series of model runs. It provides a more complete development of the computer mapping capability sought by spill responders than provided by Alternative 1. Shifting some job responsibilities and increasing the level of coordination among DNREC units would be required to support development of information for spill response by DNREC personnel. This alternative significantly increases DAWM's ability to develop and manage oil spill information.

The information content and management capabilities to be developed in Alternative 2 could be developed independently. The map information data sets can be incorporated in the simple desktop mapping capabilities identified in Alternative 1. The advanced mapping and simplified modeling capabilities do not require specific data sets. This is not the case in Alternative 1 or 3 where data sets and capabilities depend more on one another.

Alternative 3 - Real-Time Logistics Management

Alternative 3 provides for a remote access network that will allow for real-time information management during a spill, in addition to the capabilities and data sets developed under Alternative 2. Between $100K and $200K annually for three years may be needed to implement network capabilities. These will enable information tracking and allow summary reports to be generated during the course of a spill.

Resource Requirements

- All personnel, hardware, software, and contract costs under Alternative 2
- $100-$200K per year for three years

Comments and Considerations

The additional funds for this alternative are for contract work to develop electronic forms, tracking software, and remote access network capabilities.

Data Sets to be Updated or Developed

DATA SETS FROM ALTERNATIVE 2

CONTACTS

- Incident-specific contacts

SPILL MANAGEMENT

- Status boards
- Logistics tracking
- Health and safety plan
- Cost tracking
- Disposal tracking

SPILL IMPACTS

- Impacts, actual (shoreline)
- Impacts, actual (water)

Comments and Considerations

Data sets recommended under Alternative 3 that were not developed under Alternative 2 are not generated until after a spill. However, the data attributes and standard entries required must be known when spill responders "fill in the blanks" of an electronic form. Therefore, the major effort involved in these data sets is to specify data attributes (or the labels on the computer screen) and standard data entries required.

Information Management Capabilities

- All capabilities from Alternatives 1 and 2
- Electronic forms for generating and managing information during a spill
- Tracking software to maintain real-time data summaries completed during spill response at multiple sites
- A remote access network (Figure 4) to allow access to a single source of real-time information that could be updated by responders during a spill

Comments and Considerations

Many individuals may complete an array of different forms during spill response. Some of these include: 1) status board forms to document environmental conditions during a spill; 2) work plan forms to direct cleanup workers what to do on a daily basis; 3) health and safety plan forms that are completed shortly after a spill and before commencing cleanup; and 4) shoreline evaluation forms to document spill impacts. Many paper copies of each form may be completed during a spill. However, the information in these forms is often lost in the confusion of cleanup activities. One of Delaware's objectives is the capability to input the data on these forms to an electronic network so it can be stored and accessed at any time during or after cleanup. This will help to document events and conditions during a spill's damage documentation stage. However, this capability would present a difficult logistical problem when more than one individual is completing forms and when responders are in multiple staging areas during spill cleanup.

Tracking personnel, costs, and equipment is another difficult logistical problem during a spill response. Software that would enable spill responders to receive daily summaries on personnel placement, equipment movement, spill cleanup status, and expenditures on personnel, equipment, and supplies could make spill cleanup and cost recovery more efficient. To effectively track and summarize information generated during a spill, data entries would have to be made to a central data base. This action would require the establishment of a remote access network so Delaware spill responders, some equipped with portable computers, can input their data to a central

data base where all information could be summarized.

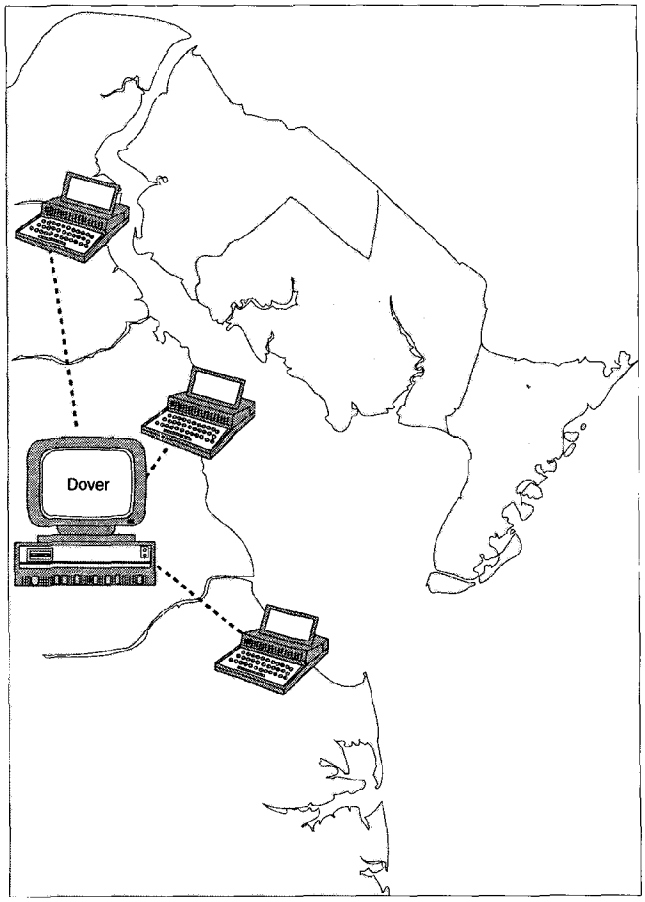
Developing the software capability for completing computer forms to track information and material flow and to generate real-time summaries is the province of private software firms who develop these capabilities for commercial purposes. These include inventory control, delivery service tracking, and reservation systems. Since this is a one-time developmental effort that requires specialized software engineering and programming skills, a contract with an experienced firm will likely be the most cost-effective approach to building these capabilities. Contract management would be the responsibility of the data base administrator identified in Alternative 2.

Since completing the work to define data sets associated with each alternative, Delaware has been made aware of new Federal requirements to monitor sites impacted by an oil spill until they recover completely. This will require the development of other data sets that keep track of economic and biological losses and recovery at spill sites. Development of these data sets would fall under the capabilities associated with this alternative.

Summary

Alternative 3 will require the largest annual increase in DAWM's budget, enough to cover the information management specialist in Alternative 2 and a contract to develop a remote access network. In addition, a small annual maintenance contract for the network software would be necessary once a network was established. This alternative is a major shift in how the State manages information during a spill. However, Delaware should consider implementing Alternatives 1 and 2 before attempting to implement Alternative 3.

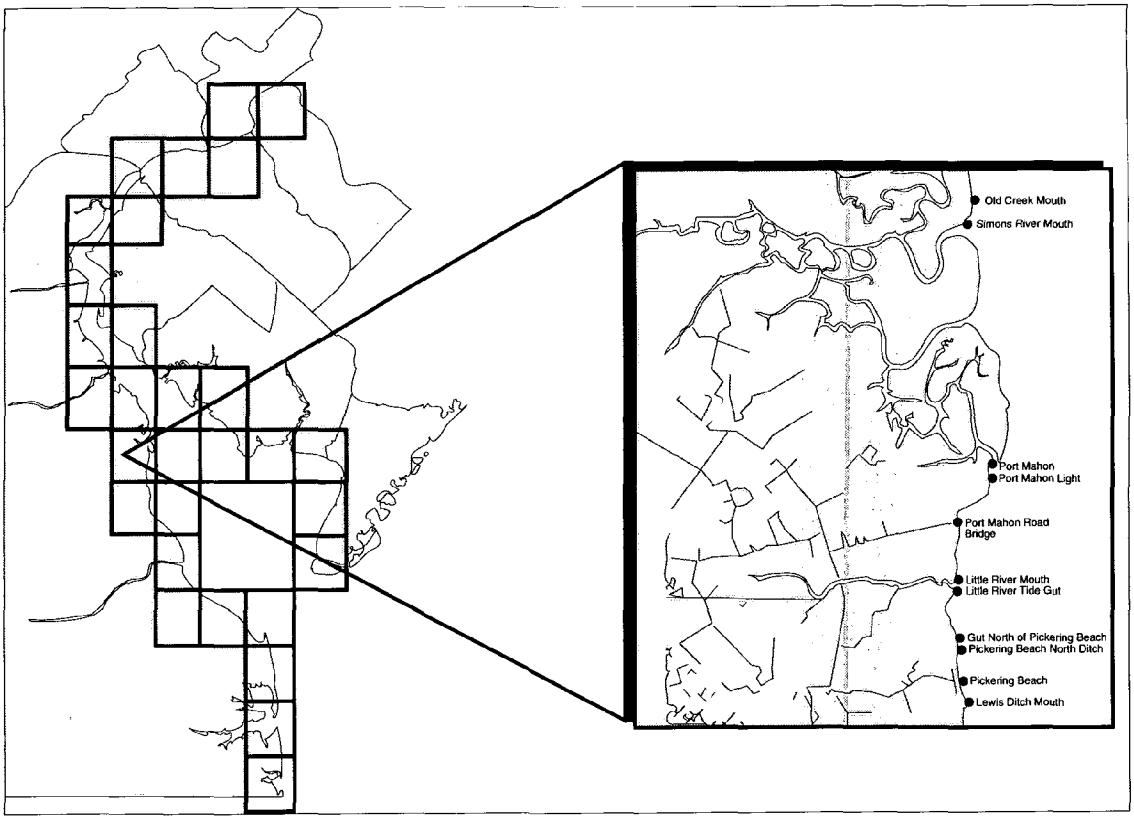
Figure 4. *Major Features of Alternative 3*



The major feature of this alternative is a remote access network for real-time information during a spill.

Implementation

Figure 5. *Potential Base Map Areas for Delaware's Oil Spill Information System*



The grid on the left represents potential base map areas for Delaware's oil spill desktop mapping. These grids correspond to USGS 7.5-minute quad maps. The map on the right, representing a single quad of Little Creek, Delaware, was generated with files from DNREC's GIS and from maps in Delaware's Oil Spill Response Contingency Plan.

First Steps

- *Select Computer Hardware Platform*
- *Select Mapping Software*
- *Select Unit(s) of Spatial (Map) Organization*
- *Construct Base Maps*
- *Create Thematic Maps*
- *Organize Map and Data File Management*
- *Create Binder of Maps and Data*

Although this report is a blueprint and not an implementation plan, a discussion of some of the first steps required for developing the oil spill information system is possible. The steps refer primarily to the mapping capability since this is the major capability underlying Alternatives 1 and 2.

What are the First Steps?

Select Computer Hardware Platform. A decision must be made on whether to develop an oil spill system on a Macintosh or IBM-compatible computer. Chief considerations will be data storage capacity, random access memory, speed of operation, cost, and in the case of Alternatives 2 and 3, portability of network-compatible units in the field. This step could be conducted simultaneously with selecting mapping software.

Select Mapping Software. "Hands on" testing of different applications will be required. Criteria include: 1) the ability to accept files exported from Delaware's GIS; 2) the maximum number of layers that can be added to a base map; 3) the number of data attributes that can be added to each map layer; 4) the ability to "look through" many layers of data for a specified geographic area; 5) ease of file management; 6) ease of use (menu commands versus typed command lines); 7) technical support by the software developer; 8) output type; and 9) the ability to link to data base software. Several commercial applications provide many of these capabilities.

Select Unit(s) of Spatial (Map) Organization. A decision must be made on an acceptable scale and level of resolution to use, as well as the geographic extent of electronic maps. A statewide or county map may not provide the detail necessary to identify tidal creeks susceptible to spilled oil, but may be satisfactory for seeing the distribution of water intakes. The USGS 7.5-minute quadrangles (Figure 5) are one alternative of spatial organization.

Construct Base Maps. This will require experimentation. Steps include: 1) determining geographic areas for each base map; 2) specifying contents and scale; and 3) constructing base maps.

Create Thematic Maps. This, too, is experimental. Steps include: 1) specifying the information content or themes for each base map; 2) determining the data to be associated with each theme; 3) creating maps; and 4) importing files of thematic data.

Organize Map and Data File Management. Organizing a geographic and data library is necessary at this stage. The various files needed to create a map (i.e., GIS export, text, boundary, data, etc.) need to be maintained so that maps can easily be recreated.

Create Binder of Maps and Data. Identify all thematic maps to be displayed in a paper map binder. Map files must be changed to picture files, exported to display software, graphically enhanced if necessary, printed, and then placed in loose-leaf binders along with associated data files.

Concluding Comments

This report presents a "blueprint" for improving information and information management capabilities that the Delaware DNREC can use in its management of oil spills in Delaware Bay. Three alternatives in this report divide the work efforts to implement the plan into two general areas: 1) development and organization of information content, and 2) electronic capabilities to make the information more understandable and accessible and ease the ongoing process of revision and updating. Of the two, development of the information content is by far the most important. Capabilities, especially when exercised in a spill management or decisionmaking context, are only as useful as the information driving them.

Electronic information management capabilities have been evolving rapidly for the past 5-10 years and will continue to evolve rapidly through the foreseeable future. In view of this ever-changing reality, the capabilities recommended in this report can only be viewed as a snapshot in time. As such, they should be considered a starting point. The need for periodic revision or complete overhaul of this "blueprint," in light of new developments in information management, is a near certainty and should be understood as an essential component of the plan's implementation.

The situation is markedly different in the more important area of information content. The information needs and the data sets available to meet those needs, with a strong, institutional commitment to developing this information, will not change at the same rapid pace as electronic management and analysis capabilities. A high likelihood of significant management benefits could extend far beyond the oil spill issue to other important areas of Delaware's coastal resource management. A continuing, steady process should be established to ensure information is developed in an organized and thought-provoking manner to meet the needs of spill responders. The process should be designed from the outset as a cooperative, multidisciplinary effort among spill responders, information management specialists, and those developing and maintaining information for spill response.